Available online at www.sciencedirect.com

ScienceDirect

Procedia - Social and Behavioral Sciences 219 (2016) 820 – 827

Procedia
Social and Behavioral Sciences

3rd Global Conference on Business and Social Science-2015, GCBSS-2015, 16-17 December 2015, Kuala Lumpur, Malaysia

Building Information Modeling as a Process of Systemic Changes for Collaborative Education in Higher Institution

Badiru Yunusa. Yusuf [a*], Kherun Nita Ali[c], Muhammad Rashid Embi[c]

[a,b,c] *Faculty of Built Environment, Universiti Teknologi Malaysia, Skudai, 81310, Johor, Malaysia*

Abstract

Building Information Modelling (BIM) is a collaborative process of building delivery and as product of IT, it has been of use and is still expanding its usefulness across professional specialization in the built environment. The adoption of BIM for project delivery is majorly a function of awareness, technical skill and education among professional specializations in the construction industry. From the literature and interview carried out by the study, there is an indication that the education sector is still lagging in its integration of BIM to education. Thus, this paper is an attempt to proffer a process of systemic changes for BIM integration to education.

Peer-review under responsibility of the Organizing Committee of the 3rd GCBSS-2015

Keywords: Building Information Modeling (BIM); Awareness, technical skill; Systemic Changes; Information Technology (IT); Collaborative Education.

1. Introduction

Building Information Modelling (BIM) has become the measure of yardstick and an international benchmark for efficiency in Architectural, Engineering, and Construction (AEC) and host of other building services. It is the platform that brings about collaboration and integration of environmental professionals and all other stakeholders. Ibrahim,

* Corresponding author: +60167765548 and +60167629422
E-mail: rashidembi@gmail.com, badiru.yusuf@gmail.com

Peer-review under responsibility of the Organizing Committee of the 3rd GCBSS-2015
doi:10.1016/j.sbspro.2016.05.072

affirm that every professional practice has particular task needed for achieving a successful BIM platform (Ibrahim and Krawczyk, 2003). Thus, BIM can now be said to encompass all phases of project development from investment conceptual stage through to architectural, civil/structural, Mechanical / electrical, cost evolvement and analysis, procurement, tendering and award, construction to completion and occupation, facility maintenance and operation, and finally the demolition of the building with a positive resultant returns on investment at the end of it live span. This is a very enormous and cumbersome tasks that can be rolled into a series of integrated tasks for easy project delivery with the use of BIM. Of course, it can be argued that these various task mentioned above have been initiated and executed successfully before the coming of BIM, but BIM is a better coordinated and integrated method whereby, time, money, decision making and precise predictions of project characters are of advantages, and besides, more potentials of BIM are still awaiting yet to be exploited (Abubakar, 2012). This is therefore the motivation and necessity for BIM integration into education for the new generation of AEC professionals. Thus, information technology era has no space for wait and see syndrome that have been historical characteristics of education sector.

Building information modeling (BIM) is a modern building delivery technology which is embraced by construction industry globally. BIM is defining and understand by many differently, but the fact still remains it is a digital model full of information for the purpose construction and management of the project throughout it life-cycle. Adopting the definition of CIDB BIM Steering Committee that 'BIM is a modelling technology and associated set of processes to produce, communicate and analyses digital information for construction life-cycle' Series of study have also reveal that BIM is having the potential to significantly change and improve performance and documentation in the construction industry, and this will invariably reduce inefficiencies, enhancing productivity, and increasing collaboration and communication (Goedert and Meadati, 2008), with the intention that BIM will achieve decreased project costs, increased productivity and quality, and reduced project delivery time (Azhar et al., 2008). Despite the success factor perceived of the BIM and the envisage potential, the embracement and the adoption of these opportunities has remained low (Becerik-Gerber et al., 2011). In Australia, it was identified that various problems facing AEC industry can be put out by the implementation of BIM as industry operational language, this give raise to the development of 'National BIM Initiative Blueprint' which was developed by BuildingSmart, meant to promote the education and adoption of BIM at higher education level. Also the blueprint is to facilitate Australia government's adoption of full collaborative BIM for all government building projects procurement coming year 2016. This is touring same line of BIM development in UK, US and other governments in the world over (Kriengsak et al., 2013). Besides, Gu and London (2010) revealed that limited understanding of industry needs and technical requirements pose a major factor hindering the advancement and adoption of BIM related technologies within the Australian AEC industry. Aksamija and Ali (2008) recent study identified "inadequate training and education" as major hindrance to the adoption BIM in the Australian AEC industry which is consistent with that being faced globally. These are challenges that BIM as an emerging technological process is facing in Australia and this largely due to inadequate education foundation BIM.

2. The Nature of Systemic Change

There has been much yarning for need for systemic change in education by the prominent educators across the globe, the like of (Boyer, 1983; Goodlad, 1984; Miller, 2006; Shanker, 1990; Banathy, 1992) and a many others. This yarning calls for the explanation of the importance and meaning of systemic change and the need for it in the education sector of today. For better understanding of this phenomenon, the needed changes can be viewed in two different ways. Piecemeal change: this is also called tinkering and it entails the modification of parts of whole, which is adjustment to a portion of a system.

Systemic changes: this is often referred to as paradigm shift. Here the changes affect all parts of whole, it is a complete and compressive adjustment to all parts of the system (Reigeluth and Garfinkle, 1994). In this age of digital and technological advancement, the second change, which is comprehensive and total adjustment of the education sector is of paramount importance; though, this is indeed a radical call, but the education system of today calls for paradigm shift taking in cognizance the dynamic digital technological world of today (Reigeluth and Garfinkle, 1994).

2.1 Needs for Systemic Change in Education

Based on the arguments put forward Bell (1976), Toffler et al. (1981), Reich (1991) and many others, that the changes of human society have undergone massive changes from agrarian age to industrial age, but for information technological age much is still expected. Ways of doing things since ages have been dynamic from one civilization to another and this is evident in societal transformations recorded. For instance, the society's changes as a result of changes from agrarian age to industrial age was massive, whereas, the change that is been witness now as a result of new information technology (digital age) is rather piecemeal and yet to be comprehensively complete (Reich, 1991; Bell, 1976; Toffler et al., 1981). Toffler et al. (1981) further noted, that human civilization are divided into three waves and each wave with its own societal super-ideology or zeitgeist, which explains reality and justification for its own existence.

- First Wave comes with the agricultural revolution
- Second wave comes with the industrial revolution
- Third wave comes with the information technology

Each of these civilization phases come along with their ideological impacts on all the spheres which make up a civilization phase such as Technology Advancement, Social Patterns, Information / Transportation Patterns and Power Patterns. The major paradigm shift in society's civilization for education system from the first wave to the second wave was a comprehensive change in sweeping ways, whereas, the changes from the second to third waves that is before our noses is piecemeal which make our education system of today obsolete (Reigeluth and Garfinkle, 1994)

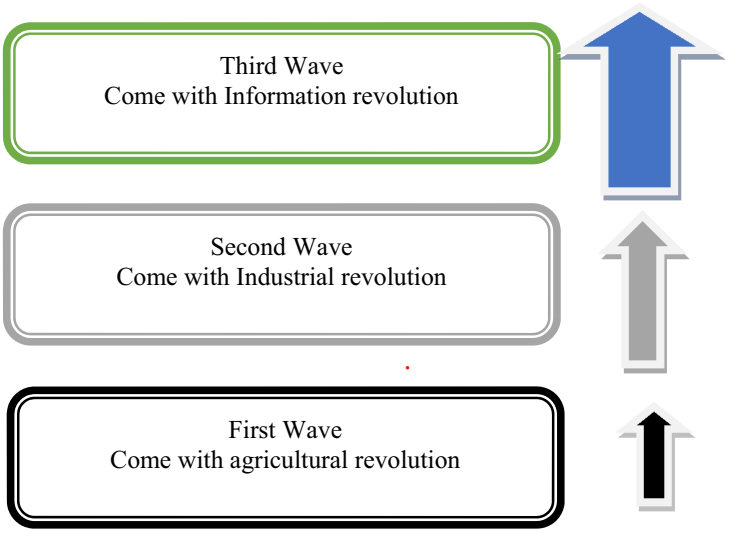

Fig 1: The three Phases of Human Civilization

2.2 A Continuum of Systemic Change

"A Continuum of Systemic Change" is an education theory that view paradigm shift in linear and distinct six developmental stages and six key elements of change (Anderson, 1993). This changes respect the shift from traditional educational system to one that emphasizes interconnectedness, active learning, shared decision making and higher

levels of achievement for all students. These elements are important to education system monitoring them can help in the understanding of an education system's progress.

Stages of Systemic Change

- *Maintenance of the Old System*: educators are conservative with the inherited system, thus reluctant to imbibe new technology.
- *Awareness*: stakeholders are becoming that current system cannot support new ideals
- *Exploration*: Educators and policymakers study and visit places that are trying new approaches. They try new ways of teaching and managing, generally in low-risk situations.
- *Transition*: The scales tip toward the new system; a critical number of opinion leaders and groups commit themselves to the new system and take more risks to make changes in crucial places.
- *Emergence of New Infrastructure*: Some elements of the system are operated in keeping with the desired new system. These new ways are generally accepted.
- *Predominance of the New System*: The more powerful elements of the system operate as defined by the new system. Key leaders begin envision even better systems.

3. Needs for BIM Adoption in Construction Industry

BIM project delivery process has been around for quite a while but the question of what is the best method of it adoption is yet to be answered. In an effort to provide answer, Coates et al. (2010) attempted to have a look at the key performance indicators (KPIs) of BIM implementation process through a joint exercise between of University of Salford and John McCall Architects through a process called Knowledge Transfer Partnership (KTP). For this exercise there are two performance indicators, how well the adoption of the BIM concept and how beneficial the adoption of BIM to practices. Also, Arayici et al. (2011) argued that the overall BIM implementation approach uses a socio-technical view in such that it does not only consider the implementation of technology but also considers the socio-cultural environment that provides the context for its implementation. Azhar et al. (2009) exploratory study confirm that BIM facilitates complex processes of sustainable design such as daylighting and solar access, it also enables automated material take-off, cost estimation and construction schedules, all these from a single integrated building model. Ellis (2006) noted that stakeholder in the building industry with virtual digital environment can now evaluate the design, construction and management of project before the actual project implementation. Influence of BIM on the construction industry are getting more dynamic at this age of technological driven society.

3.1 Educational Response to BIM

Traditionally, academic institutions are found to be slow to adopt changes especially if it pressured by a continuous flux of new technologies. In the university, curricular changes take longer time which serve as an impediment to build environment academic disciplines to match the speed at which the construction industry is advancing in this arena. in addition, there tend to be reluctance in the adoption of digital and computational approached (Sharag-Eldin and N., 2010). He further noted that academic exercises tend to challenge the technology with new needs, applications, and possibilities. This tend to delimits full integration of information technologies into curricular which is a problems that affects both the practices and the academic coursing them to miss opportunities for developing the industry as a whole. Also, it is worth noting that the need for BIM experts to fill the market gaps make it more daring for professionals and BIM software vendors to provide the basic education for students to join the industry. But there is need for caution as this may render BIM education to be delegated to part-time or graduate levels course and this will invariably reduce BIM to vocational training and limits its access to development as a theoretical and academic pursuit (Kolarevic and Malkawi, 2005). Macdonald (2011) noted that BIM is a new technology that is still struggling to be integrate to the

academic, and where this seem to have happened students are still been educated in their separate departments with little or no integration or collaborations among the discipline. BIM is an all-encompassing building delivery process, so it education should follow suit by been collaboratively taught among all AEC academic departments of higher education. Worldwide the construction industry is stirring towards more collaborative working practices among the building team family with the aid of BIM tools and process, but conversely, tertiary and professional education is lagging behind and just as industry has undergone a paradigm shift from its old combative culture to one of integration and information sharing, so also must academia. (Macdonald, 2012).

3.2 Challenges to BIM adoption.

A standard is a measured of quality and it guides the level of acceptance of a product, BIM is still a product without standards which allow array of BIM software products that lack the ability to produce interoperable files; lack of strict BIM implementation standards and rules for certain project participants, contract obligations and unified documentation to be adopted for BIM operations (Darius et al., 2013). This problem in turn affect the collaborative working together of professionals as they use different software (Gray et al., 2013). Darius et al. (2013) further noted that the fears of too low success or big failure, high initial investment costs, time to learn the use of new software and conservative approach among senior professionals are impedance to BIM adoptions. Some of these are the major challenges that are impeding BIM adoption such as lack of standardization of BIM practice, Interoperability among disciplines, Lack adequate knowledge, conservative approach of professionals, the fears of low success and big failures, high initial investment cost and lack of organizational and professional qualification alignment.

4.0 Analysis and Discussion

The paper critically examines the concept of systemic change in education and reasons why it is needed in education today. What of note is the paradigm shifts in society and the relationship between society and education, also the information-age educational system need to be based on changes in the workplace and society structure (Reigeluth, 1992; Reigeluth and Garfinkle, 1994). Building Information Modelling (BIM) has become the international benchmark for efficiency in Architectural, Engineering, and Construction (AEC) and host of other building services. Recent studies have revealed that construction industry is vital to the economic growth of most developed countries (Macdonald, 2012). It is also noted that the maximum utilization of BIM benefits cannot be fully earnest because of lack of adequate manpower in the sector. The education sector especially the higher education is still lacking behind in balancing the imbalance of the industrial needs in terms of manpower to the current turn-out (Macdonald, 2011). Taking clue from happiness in UK, US, Australia, and host of others, where BIM education is growing, integration of BIM into higher education under collaborative setting among all the building industry disciplines will enable maximum BIM benefits to be achieved at all levels.

4.1 The Open-ended Interview.

The interview were conducted through in-depth interview of practitioners in the construction industry which comprises of Architects, Quantity Surveyors, Engineers, Contractors, Project Managers and government agencies. The researcher interviewed fifteen practicing professionals across the specializations in the construction industry of which 35% of them are both in academics and practice, while 15% are construction industry contractors, and 55% are practitioners. The professional practicing academia group serve as bridge that links the two sectors of the industry. The interview is an open ended semi structured interview, which was structured in three section. The section one is to note the academic background of the respondent and year of graduation; while second section is to appreciate the respondent's BIM awareness level and how they acquired BIM knowledge. The third section touched on influence of BIM on construction phases, which includes design phase, construction phase, project management, collaboration in the industry, impediment to BIM adoption and the possible way forward it that is design, and influence of education. Therefrom the interview, thematic content analysis was adopted for the analysis of the interview and the follow facts based on the four themes generated from the interview were discussed.

4.2 BIM awareness level

The respondents across specialization made the observations that they acquired BIM knowledge from BIM social education that is workshops organize by the BIM software vendors, others from academic background acquired their knowledge from academic seminars and conferences and also from reading of BIM related article. Most practicing firms that can afford the cost of training confessed that they are being pushed to go for BIM training on client demands so that they can be commission for projects to be executed with BIM.

4.3 BIM and construction phases

The respondents appreciate the three main project phases which are design, construction and management phases and they highlights some of the influences that may result from BIM adoption and the present impediments that are delimiting its full adoption in Malaysia.

- *Design Phase:* It is believe that there are large opportunities for design innovation and creativity, but in Malaysia not all the consultancies are willing to use BIM because of lack knowledge and awareness. Some few firms that are using BIM are only using it for virtual appreciation for their clients without full detailed model that are useful for collaboration. 2D drawings are still been sent among team members. All the respondents agreed that BIM offers good time saving theoretically in Malaysia now, the benefits of time saving may later be achieve if fully adopted. They all also acknowledged the ability of BIM to resolve conflicts but many consultant still relay on the tradition methods. It is clear that respondents are awareness of BIM abilities and capability when all is BIM compliant. For cost estimation and projection, it is only very few firms that are using BIM and these few are facing the problem of not having detail model, while others still relayed on the tradition method of producing cost estimate and projection.

- *Construction Phase:* In Malaysia using BIM in construction is still theoretical, except for very few big companies, so the traditional methods is widely still in use, but with more knowledge of BIM and it acceptance among practitioners, it may be possible in future.

- *Project Management Phase:* Here in Malaysia, there is perceived changes in the building industry, but slowly, BIM is not cheap, it affordability is still a challenge, in terms of its cost and technical knowledge requirements. At full adoption, BIM will aid project management positively as can be seen from Singapore and other developed nations. BIM advocates for short-time-cost cutting and rapid project delivery and at the design stage most of the problems that may arise at later stages are resolved. Facility Management (FM) involvement in BIM at the design stage is more political and not practical, because at the design stage more is still to be resolved, though allowance is still needed to be provided for FM

4.4 Collaboration

It is agreed that there are benefits to be gained if all building team members are at the same level of awareness, but this will be difficult with this situation where the awareness and knowledge level is low and the attitude of professionals are passive toward the adoption of the new technology. In Malaysia construction industry collaboration is yet to be applicable as BIM have not been establish as a building industry working platform.

4.5 Education and Training

Due to the importance of education, the respondents believed that there are exist benefits that is to be gain with collaboration among practitioners and the academia. They all also acknowledged that the experience of the

practitioners can be extended to classroom and academia can embark on viable researches that will improve practices and also produces BIM competent graduates to the industrial market. For now there market needs of BIM experts that will lead the way and create the market, then with growing awareness in the industry the academic institutions can now step-in in the production of BIM graduate, but for now the market have not been fully established, thus, the need for BIM ready graduates is still very minimal. The government should lead the way, through legislations, monitoring and incentives to encourage the use of BIM for project delivery, then the practice should follow by complying with the directives. At the other end government should make academic institution to step-up in the production of BIM ready graduates. Also there is the opinion that the stratification and harmony of the education system will go a long way in developing BIM education that will yield positively to the growth of the industry in Malaysia and also create a matching BIM standards to the global best practice. This was the response of all due to the facts that BIM specialization need to be streamline along level of knowledge acquired. BIM is very likely to be the construction industry standard, therefore, the education of teaching and training of this technology in higher institution of learning is overdue and inevitable (Kelly, 2010)

5.0 Conclusion

Lack of BIM knowledge among professionals in the construction industry in Malaysia pose a major setback in it adoption. This is due to the fact that there is reluctance among the old professionals to go with the BIM technology, but many of them like to stay relevant in their respective specialization. Firms that are presently using BIM software started as a result of demands by their clients. Furthermore, the government through it agencies and national BIM committee are working to roll out guiding rules of BIM operation in the construction industry practices in Malaysia. However the growth of BIM globally is without limits and more breakthrough of it usage are still unfolding. Therefore, for maximum benefit to be achieved now and for making solid foundation for the upcoming generations, an unrelenting effort in producing skilled and qualified work force to the construction industry is inevitable. This calls for systemic change in education delivery to suite the new technology. From this study, the level of BIM awareness is dominantly low and few adopters mainly use it for virtual presentation. It was also discovered that there exist potential large BIM market yarning for competent graduates in a near future. For the continuity, this study suggest further study for the review of higher education curriculum in favour of BIM technology.

References

Abukar(2012). An assessment of readiness of the nigerian building design firms to adopt building information modelling (BIM) technologies. Msc Thesis, Ahmadu Bello University, Zaria.

Aksamija, A. and Ali, M.M. (2008). Information Technology and Architectural Practice. Proceedings of AIA IL Conference: Breaking New Ground, Moline, IL, .

Anderson, B.L. (1993). The stages of systemic change. Educational Leadership. 51, 14-14.

Arayici, Y., Coates, P., Koskela, L., Kagioglou, M., Usher, C. and O'reilly, K. (2011). Technology adoption in the BIM implementation for lean architectural practice. Automation in Construction. 20(2), 189-195.

Azhar, S., Brown, J. and Farooqui, R. (2009). BIM-based sustainability analysis: An evaluation of building performance analysis software. Proceedings of the 45th ASC Annual Conference.

Azhar, S., Nadeem, A., Mok, J.Y. and Leung, B.H. (2008). Building Information Modeling (BIM): A new paradigm for visual interactive modeling and simulation for construction projects. Proc., First International Conference on Construction in Developing Countries. 435-446.

Banathy, B.H. (1992). A systems view of education: Concepts and principles for effective practice. Educational Technology.

Becerik-Gerber, B., Gerber, D.J. and Ku, K. (2011). The pace of technological innovation in architecture, engineering, and construction education: integrating recent trends into the curricula. Journal of Information Technology in Construction. 16, 411-432.

Bell, D. (1976). The coming of the post-industrial society. The Educational Forum. 574-579.

Boyer, E.L. (1983). High school: A report on secondary education in America. ERIC.

Coates, P., Arayici, Y., Koskela, K., Kagioglou, M., Usher, C. and O'reilly, K. (2010). The key performance indicators of the BIM implementation process.

Darius, M., Vladimir, P., Virgaudas, J. and Leonas, U. (2013). The Benefits, Obstacles and Problems of Practical Bim Implementation. 11th International Conference on Modern Building Materials, Structures and Techniques, MBMST 2013.

Ellis, B.A. (2006). Building information modeling: an informational tool for stakeholders. Government/Industry Forum by the Federal Facilities Council. 1-5.

Goedert, J.D. and Meadati, P. (2008). Integrating construction process documentation into building information modeling. Journal of construction engineering and management. 134(7), 509-516.

Goodlad, J.I. (1984). A Place Called School. Prospects for the Future. ERIC.

Gray, M., Gray, J., Teo, M., Chi, S. and Cheung, Y.F. (2013). Building Information Modelling: An International survey. CIB 2013 World Congress.

Gu, N. and London, K. (2010). Understanding and facilitating BIM adoption in the AEC industry. Automation in construction. 19(8), 988-999.

Ibrahim, M. and Krawczyk, R. (2003). The level of knoledge of CAD objects within the Building Informatiom model. ACADIA22 ; CONNECTING CROSSROADS OF DIGITAL DISCOURSE.

Kelly, S. (2010). Student, Educator And Industry; Reconciling Digital Technologies. 44th Annual Conference of the Architectural Science Association, ANZAScA 2010, Unitec Institute of Technology.

Kolarevic, B. and Malkawi, A. (2005). Performative Architecture. Routledge.

Kriengsak, P., Wong, M.L., Doh, J.H., Stewart, R.A. and Mccarthy, T.J. (2013). Integrating building information modelling (BIM) into Engineering education: an exploratory study of industry perceptions using social network data. University of Wollongong, Research Online.

Macdonald, J.A. (2011). Bim – Adding Value By Assisting Collaboration.

Macdonald, J.A. (2012). A Framework For Collaborative Bim Education Acros The Aec Disciplines.

Miller, H. (2006). Paradigm Shift, How Higher Education is Improving Learning. Herman Miller Inc.

Reich, R. (1991). The work of nations: Preparing ourselves for twenty-first century capitalism. New York: Alfred Knopf.

Reigeluth, C.M. (1992). The Imperative for Systemic Change. Educational Technology. 32(11), 9-13.

Reigeluth, C.M. and Garfinkle, R.J. (1994). Systemic change in education. Educational Technology.

Shanker, A. (1990). The End of the Traditional Model of Schooling--And a Proposal for Using Incentives to Restructure Our Public Schools. Phi Delta Kappan. 71(5), 344-57.

Sharag-Eldin, A. and N., N.O. (2010). BIM in AEC Education. ASCE Structures Congress.

Toffler, A., Longul, W. and Forbes, H. (1981). The third wave. Bantam books New York.